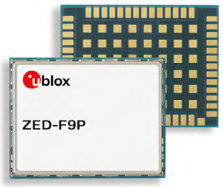
ZED-F9P

u-blox F9 high precision GNSS module

Data Sheet

Highlights

- Concurrent reception of GPS, GLONASS, Galileo and BeiDou
- Multi-band RTK with fast convergence times and reliable performance
- High update rate for highly dynamic applications
- Centimeter accuracy in a small and energy-efficient module
- Easy integration of RTK for fast time-to-market



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Document Information

Title	**ZED-F9P**	
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Product status	Corresponding content status	
In Development / Prototype	Objective Specification	Target values. Revised and supplementary data will be published later.
Engineering Sample	Advance Information	Data based on early testing. Revised and supplementary data will be published later.
Initial Production	Early Production Information	Data from product verification. Revised and supplementary data may be published later.
Mass Production / End of Life	Production Information	Document contains the final product specification.

This document applies to the following products:

Product name	Type number	Firmware version	PCN reference
ZED-F9P	ZED-F9P-00B-00	HPG 1.00B03	N/A

Contents

1 Functional description

1.1 Overview

The ZED-F9P positioning module features the new u-blox F9 receiver platform, which provides multi-band GNSS to high volume industrial applications in a compact form factor. ZED-F9P is a multi-band GNSS module with integrated u-blox multi-band RTK technology for centimeter level accuracy. The module enables precise navigation and automation of moving machinery in industrial and consumer grade products in a small surface mounted form factor.

1.2 Performance

Parameter	Specification	
Receiver type	Multi-band GNSS high precision receiver	
Accuracy of time pulse signal	RMS	30 ns
	99%	60 ns
Frequency of time pulse signal		0.25 Hz to 10 MHz (configurable)
Operational limits[1]	Dynamics	≤ 4 g
	Altitude	50,000m
	Velocity	500 m/s

GNSS		GPS+GLO +GAL+BDS	GPS+GLO +GAL	GPS+GAL	GPS+GLO	GPS+BDS	GPS
Acquisition[2]	Cold start	26 s	30 s	30 s	30 s	27 s	30 s
	Hot Start	2 s	2 s	2 s	2 s	2 s	2 s
	Aided Starts[3]	2 s	2 s	2 s	2 s	2 s	2 s
Nav. update rate	RTK	10 Hz	TBD	TBD	TBD	TBD	20 Hz
	PVT	10 Hz					25 Hz
	RAW	20 Hz					25 Hz
Convergence time[4]	RTK	< 10 s	< 10 s				
Sensitivity[5]	Tracking and Nav	-167 dBm	-167 dBm	-167 dBm	-167 dBm	-167 dBm	-167 dBm
	Reacquisition	-160 dBm	-160 dBm	-160 dBm	-160 dBm	-160 dBm	-160 dBm
	Cold start	-148 dBm	-148 dBm	-148 dBm	-148 dBm	-148 dBm	-148 dBm
	Hot Start	-157 dBm	-157 dBm	-157 dBm	-157 dBm	-157 dBm	-157 dBm
Horizontal pos. accuracy	Standalone[6]	1.5 m CEP	1.5 m CEP	1.5 m CEP	1.5 m CEP	1.5 m CEP	1.5 m CEP
	RTK[4 7]	0.01 m + 1 ppm CEP	0.01 m + 1 ppm CEP	0.01 m + 1 ppm CEP	0.01 m + 1 ppm CEP	0.01 m + 1 ppm CEP	0.01 m + 1 ppm CEP

Table 1: ZED-F9P performance in different GNSS modes

1 Assuming Airborne 4 g platform

2 All satellites at -130 dBm, except Galileo at -127 dBm

3 Dependent on the speed and latency of the aiding data connection

4 Depends on atmospheric conditions, baseline length, GNSS antenna, multipath conditions, satellite visibility and geometry

5 Demonstrated with a good external LNA

6 CEP, 50%, 24 hours static, -130 dBm, > 6 SVs

7 ppm limited to baselines up to 20 km

1.3 Supported GNSS constellations

The ZED-F9P GNSS modules are concurrent GNSS receivers which can receive and track multiple GNSS systems. Owing to the multi-band RF front-end architecture, all four major GNSS constellations (GPS, Galileo, GLONASS and BeiDou) can be received concurrently. All satellites in view can be processed to provide an RTK navigation solution when used with correction data. The ZED-F9P receiver can be configured for concurrent GPS, GLONASS, Galileo and BeiDou plus QZSS reception. If power consumption is a key factor, then the receiver can be configured for a sub-set of GNSS constellations.

The QZSS system shares the same L1 and L2 frequency bands as GPS and can always be processed in conjunction with GPS.

To take advantage of multi-band signal reception, dedicated hardware preparation must be made during the design-in phase. See the ZED-F9P Integration Manual[1] for u-blox design recommendations.

The ZED-F9P supports the GNSS and their signals as shown in Table 2.

GPS	GLONASS	BeiDou	Galileo
L1C/A (1575.42 MHz)	L1OF (1602 MHz + k*562.5 kHz, k = –7,..., 5, 6)	B1I (1561.098 MHz)	E1-B/C (1575.42 MHz)
L2 CL/M (1227.60 Mhz)	L2OF (1237 Mhz)	B2I D1/2 (1207.140 Mhz)	E5 b/Q (1207.140 Mhz)

Table 2: Supported GNSS and signals on ZED-F9P

BDS B2I is not enabled by default.

Galileo support has been implemented according to ICD release 1.3 (December 2016) and verified with live signals now that it has reached Initial Services. Full Operational Capability (FOC) is expected in 2019.

The following GNSS assistance services can be activated on ZED-F9P:

AssistNow™ Online	AssistNow™ Offline	AssistNow™ Autonomous
Supported	-	-

Table 3: Supported Assisted GNSS (A-GNSS) Services

1.4 GNSS augmentation systems

1.4.1 QZSS

The Quasi-Zenith Satellite System (QZSS) is a regional navigation satellite system that transmits additional GPS L1 C/A and L2C signals for the Pacific region covering Japan and Australia. The ZED-F9P high precision receiver is able to receive and track these signals concurrently with GPS L1 C/A and L2C signals signals, resulting in better availability especially under challenging signal conditions, e.g. in urban canyons.

1.4.2 Differential GNSS (DGNSS)

When operating in RTK mode, RTCM version 3 messages are required and the module supports DGNSS according to RTCM 10403.3. A ZED-F9P operating in rover mode can decode the following RTCM 3.3 messages:

Message Type	Description
RTCM 1001	L1-only GPS RTK observables
RTCM 1002	Extended L1-only GPS RTK observables

Message Type	Description
RTCM 1003	L1/L2 GPS RTK observables
RTCM 1004	Extended L1/L2 GPS RTK observables
RTCM 1005	Stationary RTK reference station ARP
RTCM 1006	Stationary RTK reference station ARP with antenna height
RTCM 1007	Antenna descriptor
RTCM 1009	L1-only GLONASS RTK observables
RTCM 1010	Extended L1-only GLONASS RTK observables
RTCM 1011	L1/L2 GLONASS RTK observables
RTCM 1012	Extended L1/L2 GLONASS RTK observables
RTCM 1074	GPS MSM4
RTCM 1075	GPS MSM5
RTCM 1077	GPS MSM7
RTCM 1084	GLONASS MSM4
RTCM 1085	GLONASS MSM5
RTCM 1087	GLONASS MSM7
RTCM 1094	Galileo MSM4
RTCM 1095	Galileo MSM5
RTCM 1097	Galileo MSM7
RTCM 1124	BeiDou MSM4
RTCM 1125	BeiDou MSM5
RTCM 1127	BeiDou MSM7
RTCM 1230	GLONASS code-phase biases

Table 4: Supported input RTCM 3.3 messages

A ZED-F9P operating as a base station can generate the following RTCM 3.3 output messages:

Message Type	Description
RTCM 1005	Stationary RTK reference station ARP
RTCM 1077	GPS MSM7
RTCM 1087	GLONASS MSM7
RTCM 1097	Galileo MSM7
RTCM 1127	BeiDou MSM7
RTCM 1230	GLONASS code-phase biases

Table 5: Supported output RTCM 3.3 messages

1.5 Broadcast navigation data and satellite signal measurements

The ZED-F9P high precision receiver can output all the GNSS broadcast data upon reception from tracked satellites. This includes all the supported GNSS signals plus the augmentation service QZSS. The UBX-RXM-SFRBX message is used for this information. The receiver also makes available the tracked satellite signal information, i.e. raw code phase and Doppler measurements, in a form aligned to the Radio Resource LCS Protocol (RRLP) [3]. For specification of the protocols see the u-blox ZED-F9P Interface Description [2]

1.5.1 Carrier-phase measurements

The ZED-F9P modules provide raw carrier phase data for all supported signals. This is along with pseudorange, Doppler and measurement quality information. The data contained in the UBX-RXM-RAWX message follows the conventions of a multi-GNSS RINEX 3 observation file.

Raw measurement data are available once the receiver has established data bit synchronization and time-of-week. For specification of the protocols see the u-blox ZED-F9P Interface Description [2].

1.6 Protocols and interfaces

Protocol	Type
UBX	Input/output, binary, u-blox proprietary
NMEA	Input/output, ASCII, including u-blox proprietary NMEA messages
RTCM3	Input/output, binary

Table 6: Available Protocols

For specification of the protocols see the u-blox ZED-F9P Interface Description [2].

All protocols are available on UART1, DDC (I^2C compliant) and SPI.

2 System description

2.1 Block diagram

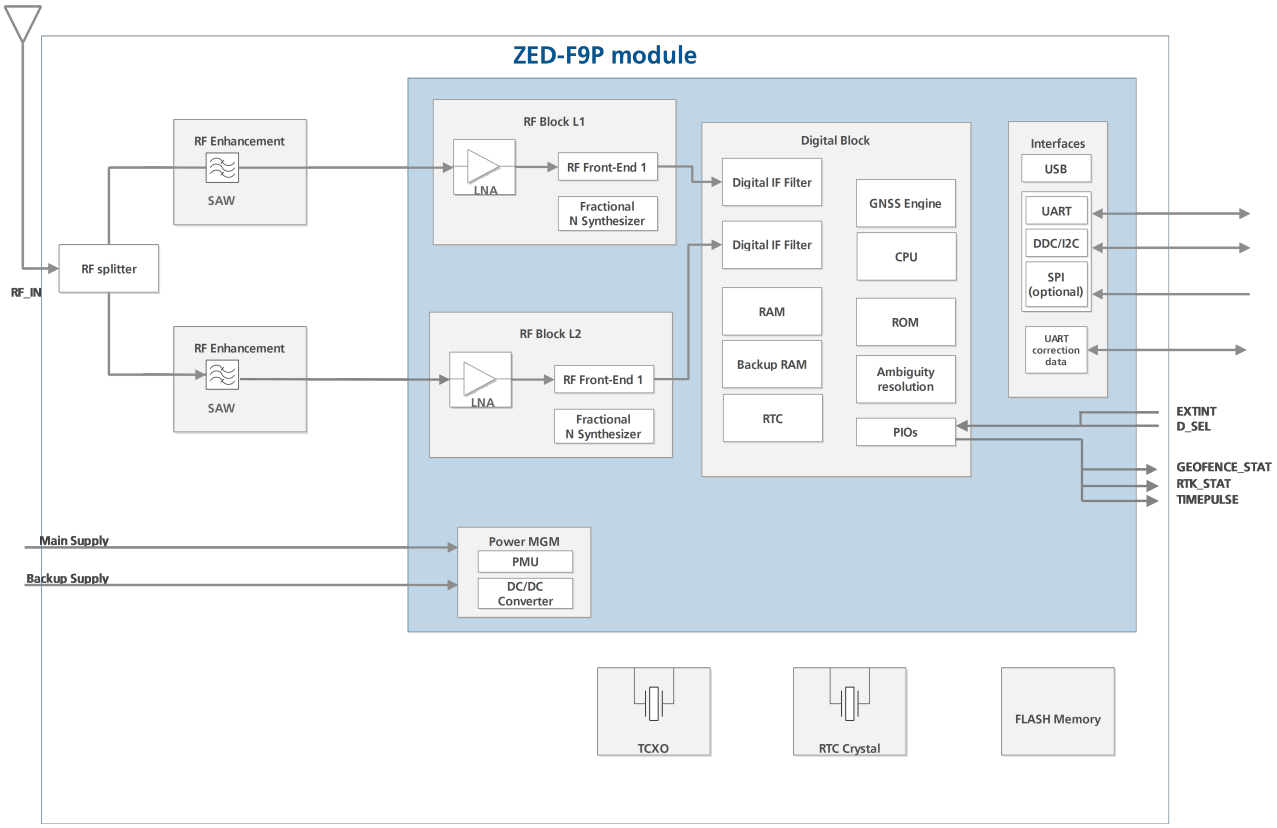


Figure 1: ZED-F9P block diagram

3 Pin definition

3.1 Pin assigment

The pin assignment of the ZED-F9P module is shown in Figure 2. The defined configuration of the PIOs is listed in Table 7. For detailed information on pin functions and characteristics, see the u-blox ZED-F9P Integration Manual [1].

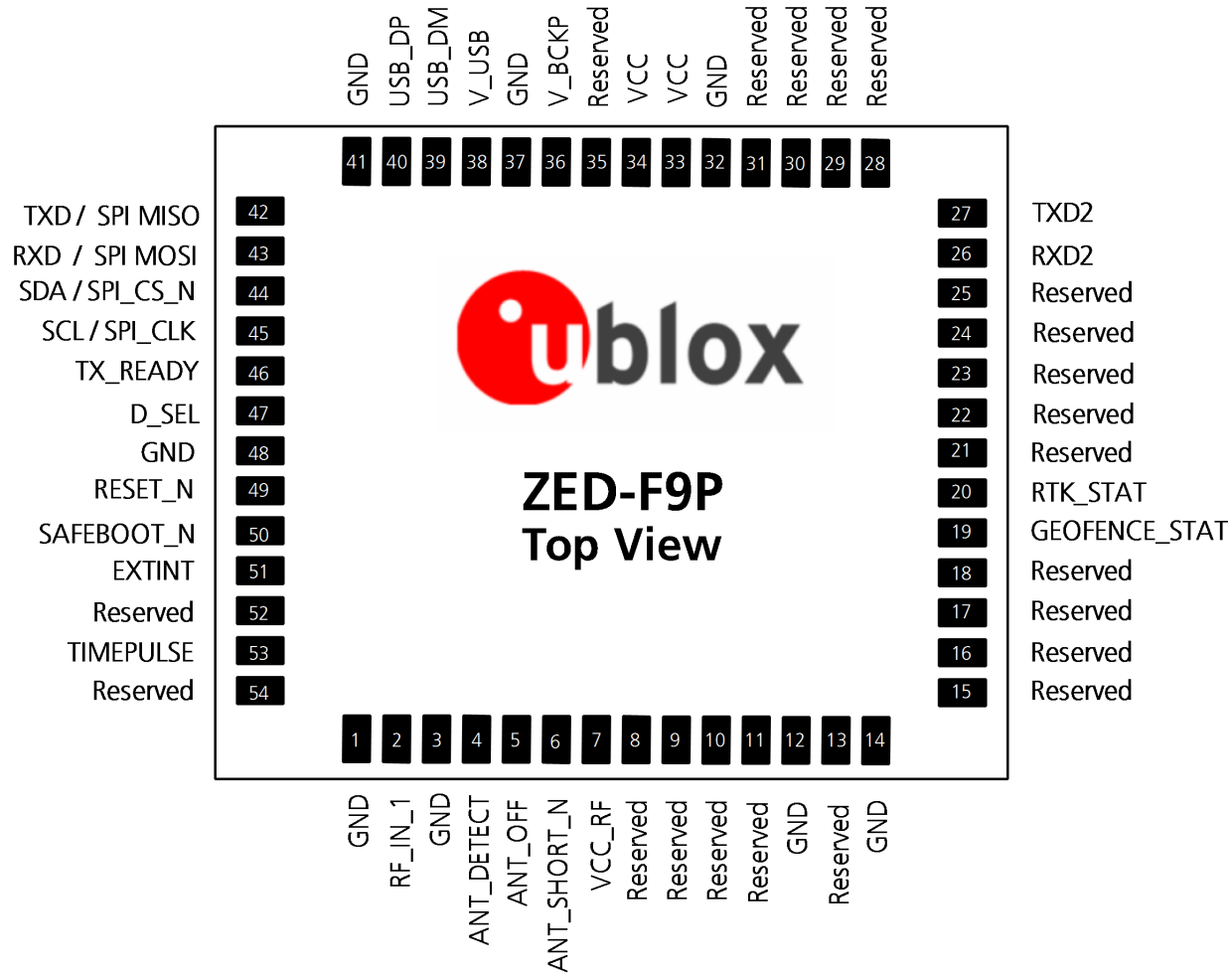


Figure 2: ZED-F9P pin assignment

Pin No	Name	I/O	Description
1	GND	-	Ground
2	RF_IN_1	I	RF input
3	GND	-	Ground
4	ANT_DETECT	I	Active antenna detect
5	ANT_OFF	O	External LNA disable
6	ANT_SHORT_N	I	Active antenna short detect
7	VCC_RF	O	Voltage for external LNA

Pin No	Name	I/O	Description
8	Reserved	-	Reserved
9	Reserved	-	Reserved
10	Reserved	-	Reserved
11	Reserved	-	Reserved
12	GND	-	Ground
13	Reserved	-	Reserved
14	GND	-	Ground
15	Reserved	-	Reserved
16	Reserved	-	Reserved
17	Reserved	-	Reserved
18	Reserved	-	Reserved
19	GEOFENCE_STAT	O	Geofence status, user defined
20	RTK_STAT	O	RTK status 0 – Fixed, blinking – receiving RTCM data, 1 – no corrections
21	Reserved	-	Reserved
22	Reserved	-	Reserved
23	Reserved	-	Reserved
24	Reserved	-	Reserved
25	Reserved	-	Reserved
26	RXD2	I	Correction UART input
27	TXD2	O	Correction UART output
28	Reserved	-	Reserved
29	Reserved	-	Reserved
30	Reserved	-	Reserved
31	Reserved	-	Reserved
32	GND	-	Ground
33	VCC	I	Voltage supply
34	VCC	I	Voltage supply
35	Reserved	-	Reserved
36	V_BCKUP	I	Backup supply voltage
37	GND	-	Ground
38	V_USB	I	USB supply
39	USB_DM	I/O	USB data
40	USB_DP	I/O	USB data
41	GND	-	Ground
42	TXD / SPI MISO	O	Host UART output if D_SEL = 1(or open). SPI MISO if D_SEL = 0
43	RXD / SPI MOSI	I	Host UART input if D_SEL = 1(or open). SPI MOSI if D_SEL = 0
44	SDA / SPI_CS_N	I/O	DDC Data if D_SEL = 1 (or open). SPI Chip Select if D_SEL = 0
45	SCL / SPI_CLK	I/O	DDC Clock if D_SEL = 1(or open). SPI Clock if D_SEL = 0
46	TX_READY	O	TX_Buffer full and ready for TX of data
47	D_SEL	I	Interface select for pins 42-45
48	GND	-	Ground
49	RESET_N	I	RESET_N
50	SAFEBOOT_N	I	SAFEBOOT_N (for future service, updates and reconfiguration, leave OPEN)
51	EXTINT	I	External Interrupt Pin

Pin No	Name	I/O	Description
52	Reserved	-	Reserved
53	TIMEPULSE	O	Time pulse
54	Reserved	-	Reserved

Table 7: ZED-F9P pin assigment

USB is currently only made available for debugging purposes.

4 Electrical specification

The limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only, and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

Where application information is given, it is advisory only and does not form part of the specification.

4.1 Absolute maximum ratings

Parameter	Symbol	Condition	Min	Max	Units
Power supply voltage	VCC		-0.5	3.6	V
Backup battery voltage	V_BCKP		-0.5	3.6	V
Input pin voltage	Vin		-0.5	VCC+0.5	V
DC current through any digital I/O pin (except supplies)	Ipin			TBD	mA
VCC_RF output current	ICC_RF			100	mA
Input power at RF_IN	Prfin	source impedance = 50 Ω, continuous wave		15	dBm
Storage temperature	Tstg		-40		°C

Table 8: Absolute maximum ratings

Attention Stressing the device beyond the Absolute Maximum Ratings may cause permanent damage. These are stress ratings only. The product is not protected against overvoltage or reversed voltages. If necessary, voltage spikes exceeding the power supply voltage specification, given in table above, must be limited to values within the specified boundaries by using appropriate protection diodes.

4.2 Operating conditions

All specifications are at an ambient temperature of 25°C. Extreme operating temperatures can significantly impact specification values. Applications operating near the temperature limits should be tested to ensure the specification.

Parameter	Symbol	Min	Typical	Max	Units	Condition
Power supply voltage	VCC	2.7	3.0	3.6	V	
Backup battery voltage	V_BCKP	1.65		3.6	V	
Backup battery current	I_BCKP		80		µA	
SW backup current	I_SWBCKP		100		µA	
Input pin voltage range	Vin	0		VCC	V	
Digital IO Pin Low level input voltage	Vil	0		0.8	V	
Digital IO Pin High level input voltage	Vih	2		VCC+0.3	V	
Digital IO Pin Low level output voltage	Vol			0.4	V	Iol = 2 mA
Digital IO Pin High level output voltage	Voh	VCC – 0.4			V	Ioh = 2 mA
VCC_RF voltage	VCC_RF		VCC - 0.1		V	
VCC_RF output current	ICC_RF			50	mA	

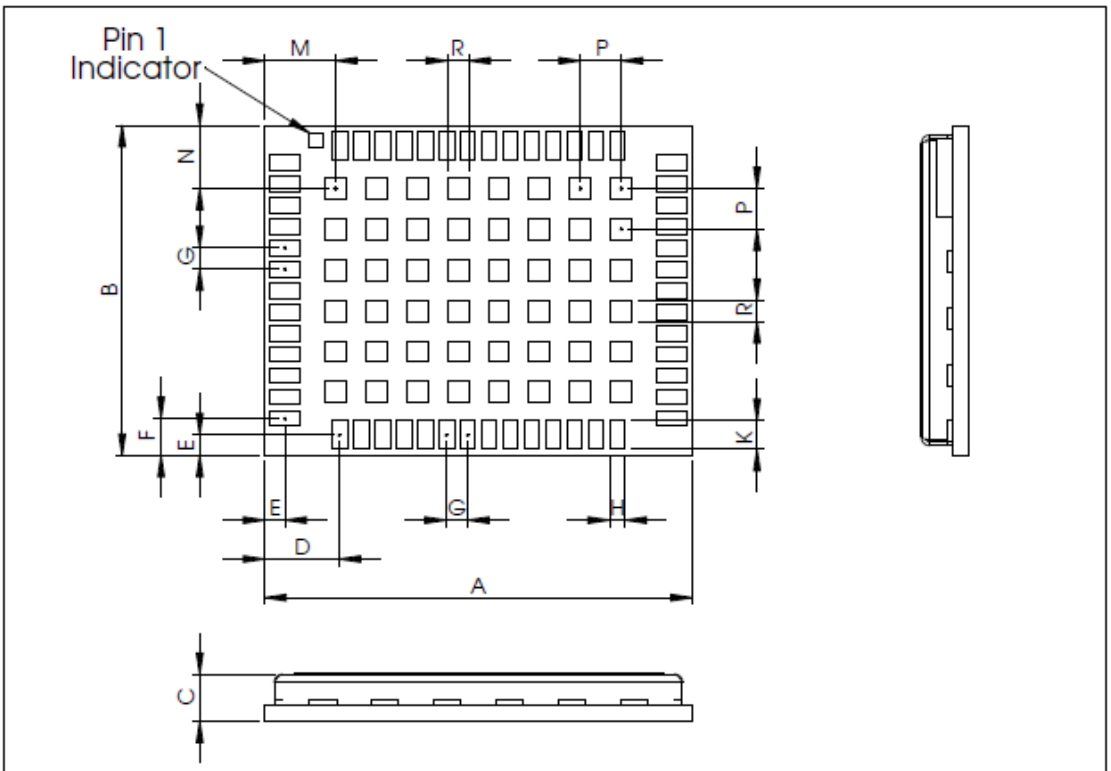
Parameter	Symbol	Min	Typical	Max	Units	Condition
Receiver Chain Noise Figure[8]	NFtot		TBD		dB	
Operating temperature	Topr	-40		85	°C	

Table 9: Operating conditions

Operation beyond the specified operating conditions can affect device reliability.

[8] Only valid for the GPS band

5 Mechanical specification



Symbol	Min. (mm)	Typ. (mm)	Max. (mm)
A	21.80	22.00	22.20
B	16.80	17.00	17.20
C	2.20	2.40	2.60
D	tbd	3.85	tbd
E	tbd	1.05	tbd
F	tbd	1.90	tbd
G	tbd	1.10	tbd
H	tbd	0.80	tbd
K	tbd	1.50	tbd
M	tbd	3.65	tbd
N	tbd	3.25	tbd
P	tbd	2.10	tbd
R	tbd	1.10	tbd
Weight		tbd	

Figure 3: ZED-F9P mechanical drawing

6 Reliability tests and approvals

All u-blox modules are based on AEC-Q100 qualified GNSS chips.

Tests for product family qualifications are according to ISO 16750 "Road vehicles – environmental conditions and testing for electrical and electronic equipment", and appropriate standards.

6.1 Approvals

Products marked with this lead-free symbol on the product label comply with the "Directive 2002/95/EC of the European Parliament and the Council on the Restriction of Use of certain Hazardous Substances in Electrical and Electronic Equipment" (RoHS). All u-blox modules are RoHS compliant and green (no halogens).

7 Labeling and ordering information

7.1 Product labeling

The labeling of the ZED-F9P modules provides product information and revision information. For more information please contact sales.

7.2 Explanation of product codes

Three different product code formats are used. The **Product Name** is used in documentation such as this data sheet and identifies all u-blox products, independent of packaging and quality grade. The **Ordering Code** includes options and quality, while the **Type Number** includes the hardware and firmware versions. Table 10 below details these three different formats.

Format	Structure
Product Name	ZED-F9P
Ordering Code	ZED-F9P-00B
Type Number	ZED-F9P-00B-00

Table 10: Product code formats

7.3 Ordering codes

Ordering No.	Product
ZED-F9P-00B	u-blox ZED-F9P

Table 11: Product ordering codes

Product changes affecting form, fit or function are documented by u-blox. For a list of Product Change Notifications (PCNs) see our website at: https://www.u-blox.com/en/product-resources.

8 Related documents

1. ZED-F9P Integration Manual , Docu. No. UBX-18010802
2. ZED-F9P Interface Description, Docu. No. UBX-18010853
3. Radio Resource LCS Protocol (RRLP), (3GPP TS 44.031 version 11.0.0 Release 11)

For regular updates to u-blox documentation and to receive product change notifications please register on our homepage (http://www.u-blox.com).

9 Revision history

Revision	Date	Name	Status / Comments
R01	21-May-2018	ghun/jhak	Objective Specification

Contact

For complete contact information visit us at www.u-blox.com.

u-blox Offices

North, Central and South America

u-blox America, Inc.
Phone: +1 703 483 3180
E-mail: info_us@u-blox.com

Regional Office West Coast
Phone: +1 408 573 3640
E-mail: info_us@u-blox.com

Technical Support
Phone: +1 703 483 3185
E-mail: support_us@u-blox.com

Headquarters
Europe, Middle East, Africa

u-blox AG
Phone: +41 44 722 74 44
E-mail: info@u-blox.com
Support: support@u-blox.com

Documentation Feedback
Email: docsupport@u-blox.com

Asia, Australia, Pacific

u-blox Singapore Pte. Ltd.
Phone: +65 6734 3811
E-mail: info_ap@u-blox.com
Support: support_ap@u-blox.com

Regional Office Australia
Phone: +61 2 8448 2016
E-mail: info_anz@u-blox.com
Support: support_ap@u-blox.com

Regional Office China (Beijing)
Phone: +86 10 68 133 545
E-mail: info_cn@u-blox.com
Support: support_cn@u-blox.com

Regional Office China (Chongqing)
Phone: +86 23 6815 1588
E-mail: info_cn@u-blox.com
Support: support_cn@u-blox.com

Regional Office China (Shanghai)
Phone: +86 21 6090 4832
E-mail: info_cn@u-blox.com
Support: support_cn@u-blox.com

Regional Office China (Shenzhen)
Phone: +86 755 8627 1083
E-mail: info_cn@u-blox.com
Support: support_cn@u-blox.com

Regional Office India
Phone: +91 80 4050 9200
E-mail: info_in@u-blox.com
Support: support_in@u-blox.com

Regional Office Japan (Osaka)
Phone: +81 6 6941 3660
E-mail: info_jp@u-blox.com
Support: support_jp@u-blox.com

Regional Office Japan (Tokyo)
Phone: +81 3 5775 3850
E-mail: info_jp@u-blox.com
Support: support_jp@u-blox.com

Regional Office Korea
Phone: +82 2 542 0861
E-mail: info_kr@u-blox.com
Support: support_kr@u-blox.com

Regional Office Taiwan
Phone: +886 2 2657 1090
E-mail: info_tw@u-blox.com
Support: support_tw@u-blox.com